The Museum of Modern Art

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Checklist for Once Invisible exhibition - June 20 - September 11, 1967

"Thus photography, from being merely another way of procuring or making images of things already seen by our eyes, has become a means of ocular awareness of things that our eyes can never see directly. It has become the necessary tool...for all visual knowledge of the literally unseeable... . unseeable whether because too small, too fast, or hidden under surfaces, and because of the absence of light....It has effected a very complete revolution in the way we use our eyes and, especially, in the kinds of things our minds permit our eyes to tell us."

William M. Ivins, Jr.
Prints and Visual Communication

In the past century a new source of imagery has come from the experiments of scientifically motivated photography. Such work has been independent of artistic traditions, and unconcerned with aesthetic standards. It is in the most exact sense documentary photography; its aim is to describe precisely specific facts and happenings.

Some of this work has provided visual data which would have been unavailable without the intercession of photography--data inaccessible to the eye even when aided by the optical microscope or telescope. Such pictures have extended our sense of the visually possible. They are the subject matter of this exhibition.

The many varieties of visual experiment which are represented in this exhibition can be divided into three fundamental classes. The first relates to photography's role in analysing time and motion. The second is comprised of images created by the focusing of invisible energy sources. The third class shows pictures made from vantage points inaccessible to men.

This exhibition is not a survey of scientific photography. Its subject matter is the form--the morphology, not the function--of the pictures shown. These pictures were made in the pursuit of knowledge; they are included here, however, not because of their scientific importance, but because of their role in expanding our visual imagination.

It is perhaps no longer possible to equate the concerns of science with those of art, as it was for Constable, who could say "painting is a science, and should be pursued into an inquiry into the laws of nature." It is nevertheless suggestive to consider that the qualities that characterize these images--coherence, clarity, economy and surprise--are the source of their value both as scientific documents and as sources of wonder.

John Szarkowski

1. Serial time exposures of Moon eclipse December 30, 1963 made with Baker-Nunn satellite tracking camera. Total time of exposures 28 minutes. SMITHSONIAN ASTROPHYSICAL OBSERVATORY/Print courtesy of Eastman Kodak Co.

2. Aerial false color infrared of grain crop from plane flying at 5000', Texas, 1966. G. H. SCHROEDER/Mark Systems Inc.

3. Radiograph of Peruvian wood beetle. EASTMAN KODAK COMPANY

The Analysis and Synthesis of Time

In 1878 Eadweard Muybridge made the first wholly successful photographs of a galloping horse. They demonstrated that the ancient and universally accepted conventions for drawing that subject were radically incorrect. By implication, they proved that the eye was incapable of comprehending even moderately rapid movement. (Muybridge fixed the movement of a running horse with an exposure time of one two-thousandth of a second. Ultra high speed photography today is defined as exposures of one ten-millionth of a second or shorter.)

Soon after the first publication of Muybridge's work, the painter Thomas Eakins and the physiologist J. E. Marey independently made photographs that recorded both motion and the passage of time. In these pictures, repetitive exposures on a single plate synthesized (or accumulated) the image of a body moving through both space and time.

Photography's ability to form images from signals received over an extended period is also utilized in astronomical photography, where prolonged exposures record brightnesses so low that they are invisible even through the most powerful telescopes. In this case the camera pans on an apparently moving subject in order to hold the image fixed. Conversely, the camera's lens can extend the angle of its vision by panning across a stationary subject, and reduce even a three hundred and sixty degree pan to a flat plane.

Perhaps the most astonishing examples of photography's ability to redefine the nature of time and motion exist in some modern aerial survey pictures, which record a continuous image from a continuously changing vantage point. In these pictures the vanishing point or traditional perspective drawing has become a line. The picture is made from no special place, at no particular time.

4. Serial high speed photograph of man walking. Linear graph made with white stripes painted on black clothes, c. 1882. JULES ETIENNE MAREY/ Cinémathèque Francaise, Paris

5. High speed electronic flash photograph, 1/50,000 second, of a spinning baseball showing Magnus Effect in smoke-filled wind tunnel. PROFESSOR H. N. M. BROWN / University of Notre Dame

6. High speed schlieren photograph, 1/1,500,000 second, of blocked shock waves produced by the 3" diameter cone being too big for the wind tunnel at this position. JAMES B. COOPER/ University of Michigan

7. High speed serial photograph of explosive disk simultaneously detonated at 8 equidistant points showing primary and secondary shock waves. Taken at 600,000 frames per second; each exposure is 6/10,000,000 second.
DAVID ABERNATHY/ U. S. Naval Weapons Laboratory

8. Stroboscopic photograph of W. E. Fesler kicking a football, c. 1935.
DR. HAROLD E. EDGERTON

9. High speed photographs of the coalescence of water drops.
left: air caught in pulsed drop
center: formation of drop
right: internal flow front in oscillating drop
R. WAYNE ANDERSON/ The Dow Chemical Company

10. Mosaic of high speed photographs of model swinging baseball bat, 1885.
EADWEARD MUYBRIDGE

11. High speed photograph, 1/50,000 second, of smoke from a burning cigarette.
PROFESSOR H.N.M. BROWN/ University of Notre Dame

12. Mosaic high speed shadowgraph of projectile.
R. L. ROWE/ U. S. Army Ballistic Research Laboratories, Aberdeen Proving Ground

13. Mosaic of high speed photographs of horse's gaits, c. 1885
JULES ETIENNE MAREY/ Cinémathèque Française

14. Mosaic of high speed photographs of Belgian horse Hansel trotting, 1885.
EADWEARD MUYBRIDGE

15. Mosaic of high speed photographs of nude kicking a hat, 1885.
EADWEARD MUYBRIDGE

16. Mosaic of high speed photographs of model throwing an iron disk, 1885.
EADWEARD MUYBRIDGE

17. Mosaic of high speed photographs of nude walking, from series on abnormal movement, showing muscular atrophy of the legs, 1885.
EADWEARD MUYBRIDGE

18. Mosaic of high speed photographs of models fencing, 1885.
EADWEARD MUYBRIDGE

19. Serial high speed photograph showing acceleration of falling ball, c. 1887.
JULES ETIENNE MAREY/ Courtesy of André Jammes, Paris

20. High speed photo-macrograph, 1/20,000 second, of flies pulling model plane.
DAVID B. EISENDRATH, JR.

21. Time exposure of Explorer I and stars taken with Baker-Nunn satellite tracking camera.
SMITHSONIAN ASTROPHYSICAL OBSERVATORY

22. Stroboscopic photograph of swinging pendulum showing potential energy transferred to kinetic energy and back again.
BERENICE ABBOTT

23. High speed photograph of tracks of protons interacting in 80" liquid hydrogen bubble chamber.
BROOKHAVEN NATIONAL LABORATORY

24. Time exposure of helicopter take-off at night.
ANDREAS FEININGER

25. Serial high speed photograph of fencer lunging, 1885.
JULES ETIENNE MAREY/ Cinémathèque Française, Paris

26. Stroboscopic photograph of Joe Levis saluting, c. 1935.
DR. HAROLD E. EDGERTON

27. Time exposure, 45 minutes, of North American Nebula in Cygnus Constellation, 1953.
PALOMAR OBSERVATORY/ National Geographic Society

28. Panoramic photograph of the 13th Annual Outing and Dinner of the United Commercial Travelers, 1916, made with the Cirkut camera.
F. W. BREHM/ George Eastman House, Rochester, New York
Although not made for scientific reasons, this photograph to the right is an early example of photography's ability to accumulate in one picture information which cannot be seen at any one moment. The photograph by F.W. Brehm apparently shows at least five people more than were actually present. Several people at the left hand edge of the group can also be seen on the right hand half of the picture. The principle involved, which depends upon the coordinated movement of both lens and film, is the same as that utilized in the 360 degree panorama of the Brooklyn Bridge below.

29. 360 degree panoramic photograph of the Brooklyn Bridge.
ZOOMAR, INC.

30. 2 time exposures of Moon during first and last quarters.
PARIS OBSERVATORY/ Courtesy of Amco, Inc.

31. Partial wide angle mosaic photograph made from 6.4 degree scans of the Lunar horizon and transmitted to Pasadena, Cal., June 16, 1966. Curvature due to non-vertical mounting of the camera.
SURVEYOR I/NASA

32. 360 degree panoramic photograph of the Chicago skyline.
ZOOMAR, INC.

33. 180 degree aerial panoramic photograph of freighter crossing the Chesapeake-Delaware Canal, from jet plane flying 600 knots at 1000 feet.
FAIRCHILD SPACE AND DEFENSE SYSTEMS

34. 120 degree aerial panoramic photograph of Washington, D. C., from plane flying at high altitude, 1964. THE PERKIN-ELMER CORPORATION

35. High speed shadowgraph of buckshot and wad from shot gun.
R. L. ROWE/ U. S. Army Ballistic Research Laboratories
Aberdeen Proving Ground

36. 180 degree aerial panoramic photograph of Manhattan from plane flying at low altitude, 1965.
THE PERKIN-ELMER CORPORATION

37. 180 degree aerial panoramic photograph of Verrazano Narrows Bridge from plane flying at low altitude, 1965. PERKIN-ELMER CORPORATION

38. High speed interferogram (and four derivations) of 3/4" plastic sphere in flight
R. L. ROWE/ U. S. Army Ballistic Research Laboratories
Aberdeen Proving Ground

39. Mosaic high speed shadowgraph of blast region of a gun.
R. L. ROWE/ U. S. Army Ballistic Research Laboratories
Aberdeen Proving Ground

40. Stroboscopic photograph of Ralph Guldahl's golf swing, c. 1935.
DR. HAROLD E. EDGERTON

Kiosks in center section - clockwise:

41. Time exposure of tidal flow pattern in model of estuary. Electric flash near end of exposure shows direction of flow of styrofoam block indicators.

F. B. GAUTIER/ U. S. Army Waterways Experiment Station, Vicksburg, Miss.

42. High speed electronic flash photograph of milk drop splashing, c. 1935.
DR. HAROLD E. EDGERTON

43. High speed photograph, 1/50,000 second, of a propeller rotating at 4080 r.p.m. in smoke-filled wind tunnel.
PROFESSOR H. N. M. BROWN/ University of Notre Dame

44. Serial high speed schlieren photograph showing interaction between shock wave and butane flame.
G. H. MARKSTEIN/ Cornell Aeronautical Laboratory, Inc. Made for Office of Naval Research, Project SQUID

45. High speed photograph of fluid mapper.
PROFESSOR A. D. MOORE/ Univeriity of Michigan

46. Time exposure of free swinging neon lamp pulsing at 100 cycles per second.
R. WAYNE ANDERSON/ The Dow Chemical Company

47. Electronic flash photograph of hummingbird (Melanotrochilus Fuscus, Santa Teresa, Espiritu Santo, Brazil).
CRAWFORD H. GREENEWALT

48. 3 minute exposure made by Baker-Nunn satellite tracking camera of Comet Ikeya-Seki receding from Earth at 5000 mph showing dust tail 70 million miles long, October 29, 1965.
J. T. WILLIAMS AND CARLOS TRONCOSO-MAZA/ Smithsonian Astrophysical Observatory

49. Stroboscopic photograph of projectile striking nylon, as seen in revolving mirror.
DR. FLOYD A. ODELL

50. High speed photograph, 1/3,000,000 second, of 4" tin wire exploding.
WILLIAM G. CHACE, COLGATE V. FISH AND K. A. SAARI
Air Force Cambridge Research Laboratories

51. High speed color schlieren photograph of supersonic air flow past fixed model in wind tunnel. Each color represents a different degree of airflow.
PAUL H. CORDS, JR./ U. S. Naval Ordnance Laboratory

52. 360 degree view of an automobile piston made with eripheral camera.
SHELL DEVELOPMENT COMPANY

53. 180 degree aerial panoramic photograph of industrial section in Northern Japan from jet plane flying 550 knots at 1800 feet.
FAIRCHILD SPACE AND DEFENSE SYSTEMS

54. High speed radiograph of Colt .45
FIELD EMISSION CORPORATION

55. Time exposure of Sputnik I rocket body made with Baker-Nunn satellite tracking camera, October 17, 1957, Pasadena, Cal.
SMITHSONIAN ASTROPHYSICAL OBSERVATORY

56. High speed electronic flash photograph of a hummingbird (Chrysolampis Mosquitos, Santa Teresa, Espiritu Santo, Brazil). CRAWFORD H. GREENEWALT

57. High speed electronic flash photograph of a "nor-or gate" fluid amplifier in a digital computer (a device which switches mechanically rather than electrically).
WILLIAM VANDIVERT/ Made for Scientific American

58. High speed film of tracks of protons interacting in an 80" liquid hydrogen bubble chamber.
BROOKHAVEN NATIONAL LABORATORY

59. High speed film, 1 million frames/second, of sympathetic detonation of Pentolite high explosives.
MORTON SULTANOFF/ U. S. Army Ballistic Research Laboratories
Aberdeen Proving Ground

60. Projected color photographs of astronomical subjects:
    1. Veil Nebula of Cygnus
    2. Planetary Nebula "Ring" in Lyra.
    3. The "Crab" Nebula in Taurus.
    4. Gaseous Nebula in Orion.
    5. The Great Galaxy in Andromeda.
    6. Gaseous Nebula "Lagoon" in Sagittarius.
    7. Planetary Nebula "Dumbbell" in Vulpecula.
    8. Galaxy in Sculptor.
    9. Galaxy in Triangulum.
    10. Gaseous Nebula "Trifid" in Sagittarius.
    11. Pleiades, an open star cluster in Taurus.
    12. Comet Humason 1961.
    13. Gaseous Nebula "Horsehead" in Orion.
    14. Gaseous Nebula "Rosette" in Monoceros.
    15. Gaseous Nebula in Serpens.
    16. Gaseous Nebula "Omega" in Sagittarius.
    17. Planetary Nebula in Aquarius.
    18. Galaxy in Pegasus.
    19. Planetary Nebula in Aquila.
    20. Gaseous Nebula "North American" in Cygnus.

WILLIAM C. MILLER/ Mount Wilson and Palomar Observatories.

South Section from right to left

Invisible Energy Sources

Roentgen announced his discovery of the X-ray in 1895, and showed "photographs" formed from energy other than visible light. Photography had already experimentally recorded the invisible ends of the spectrum--ultraviolet and infrared--and had revealed previously hidden information by photographing only selected portions of the visible light spectrum. In the early 1930's experimental electron microscopes first recorded images formed by electron emission, which was focused by a magnetic field rather than an optical lens. The infrared evaporagraph translated heat differential into color changes; the sound spectrogram recorded sound as graphic pattern.

Each of these picture-making systems opened fields of investigation that were closed to the illumination offered by visible light. Images formed by sound, or heat, or infrared radiation can be made in the dark. The electron beam is much smaller in physical dimension than a wave of light; like a pencil with a sharper point, it can describe proportionately finer detail.

61. Radiograph of 9th century B. C. mummy from Harwa, Egypt.
THE FIELD MUSEUM, CHICAGO

62. above: Electron micrograph of fog droplet nuclei.
EDWIN S. C. BOWLER/ University of California

63. above right: Electron micrograph of cat lung. Original magnification 5200x.
DR. KENNETH A. SIEGESMUND/ Marquette University School of Medicine, Wisconsin

64. far right: Radiograph of Madonna and Child attributed to Rondinelli. (detail)
THE WALTERS ART GALLERY, BALTIMORE

65. Radiograph of a milkweed.
EASTMAK KODAK COMPANY

66. Radiograph of a columbine.
EASTMAN KODAK CCMPANY

67. Radiograph of a sting ray.
EASTMAN KODAK COMPANY

68. Radiograph of a jet engine.
EASTMAN KODAK COMPANY

69. Radiograph of snake eating a hamster.
ROBERT LOGAN/ American Museum of Natural History

70. top: Computer-analyzed picture reducing continuous toned image to 8 component brightness levels.

71. bottom: Dot pattern derived by computer from above.

JOHN MOTT-SMITH/ Air Force Cambridge Research Laboratories, Bedford, Mass.

72. Electron micrograph of surface view of blushed coating.
HAROLD B. BERG/ Interchemical Corporation

73. Electron micrograph of fenestrated gelatin film. Original magnification 10,000x.
DR. ALAN P. MACKENZIE/ American Foundation for Biological Research

74. Elecyron micrograph of a BeO surface. Original magnification 10,000x.
DOUGLAS MATTERN and ROBERT WARNECKE/ Fairchild Semiconductor

75. Electron micrograph of alveolar cell of normal mouse lung.
DR. CATHERINE E. THOMAS and MRS. W. JANSEN/ The University of Manitoba

76. Radiograph of spindle shell.
EASTMAN KODAK COMPANY

77. Electron micrograph of capillary blood vessel of human kidney.
MARGUERITE M. YOUNGMAN/ University of Alberta

78. Electron micrograph of lipid aggregate in cerebral neuron of Tay-Sachs disease.
DR. ROBERT TERRY/ Albert Einstein College of Medicine

79. Electron micrograph of retinulae of "skipper" butterfly.
DR. H. FERNANDEZ-MORAN/ The University of Chicago

80. Electron micrograph of vanadium pentoxide gel. Original magnification 20,000x.
DR. JOHN H. L. WATSON/ Edsel B. Ford Institute for Medical Research

81. Transmission X-ray diffraction of silicon showing stacking faults and dislocations.
DR. G. H. SCHWUTTKE/ IBM CORPORATION (Partially sponsored by Air Force Cambridge Research Laboratories)

82. Electron micrograph of leech hypodermis.
DR. ALLEN W. CLARK/ University of California, Berkeley

83. Time exposure of a simulated far field microwave antenna (2400 miles from Earth) showing complicated energy patterns.
CONDUCTRON CORPORATION

84. Electron micrograph of accidental crystallization of uranyl acetate. Original magnification 1700x.
DR. O. JAMES INASHIMA/ Northeastern University, Boston. Courtesy of Carl Zeiss, Inc.

85. Electron micrograph of glycogen bodies in x-irradiated spinal cord tissue. Original magnification 52,000x.
DR. EDMUND B. MASUROVSKY/ Columbia University

86. Electron micrograph of sulfuric acid droplet.
JAMES P. LODGE and EVELYN R. FRANK/ National Center for Atmospheric Research, Boulder, Colo.

87. Photograph of sun with all but the far red of the spectrum filtered out.
WENDELSTEIN OBSERVATORY, WEST GERMANY/ Courtesy of Carl Zeiss, Inc.

88. Electron micrograph scan of hair on fly's tongue. Original magnification 2500x.
WESTINGHOUSE ELECTRIC CORPORATION

89. Radiograph of fossil gar.
AMERICAN MUSEUM OF NATURAL HISTORY

90. Radio-autograph of zinc in tomato fruit.
DR. PERRY R. STOUT/ University of California, Davis

91. X-ray diffraction of beryl.
EASTMAN KODAK COMPANY

92. & 93 Speech spectrogram of song of a wood thrush
top: bar type
bottom: shaded contour type
VOICEPRINT LABORATORIES, INC.

94. Radiograph of sea horse.
EASTMAN KODAK COMPANY

95. Electron micrograph of a hole in a forvarm film.
DR. VOJTECH BYSTRICKY/ Polytechnic Institute of Brooklyn

96. Photograph made with "Pinger" probe of strata beneath Boston Harbor showing Callahan and Sumner tunnels, 1966.
EG&G INTERNATIONAL, INC.

97. Side-scan sonar photograph of harbor floor, New Providence, Bahamas, 1966.
EG&G INTERNATIONAL, INC.

98. Electron micrograph of trichohyalin and keratin filaments.
PAUL PARAKKAL/ Boston University School of Medicine

99. Electron micrograph of alumina. Original magnification 8000x.
A. M. REINGOLD/ IRC, INC.

100. Electron micrograph of sodium chloride crystal, thermally etched. Original magnification 1400x.
DR. MARIA J. DE ABELEDO and MRS. LELIA S. DE WAINER / National Commission of Atomic Energy of Argentina

101. Evaporagraph of fuse bank showing burned out fuse on one end.
R. WAYNE ANDERSON/ The Dow Chemical Company

102. Evaporagraph of 2 paper cups with right cup filled with warmer liquid than one on left; darker blue ring shows evaporation which causes cooling.
FRANK B. ELAM/ Ashland Works, Armco Steel

103. Evaporagraph of 6" brick insulated pipe carrying off hot gases from blast furnace.
FRANK B. ELAM/ Ashland Works, Armco Steel

104. Evaporagraph of steam pipe showing whistle to be very hot indicating the valve was leaking.
FRANK B. ELAM/ Ashland Works, Armco Steel

105. Electron micrograph of yolk platelets in tissue of toad embryo. Original magnification 50,000x.
DR. JACK ROSENBLUTH/ New York University Medical Center

106. False color infrared photograph of river delta at low tide, Montrose Basin, Scotland. Red represents underwater vegetation.
DR. WALTER CLARK/ Eastman Kodak Company

107. Electron micrograph of bismuth telluride by direct transmission. Original magnification 3500x.
C. GADZIALA/ American Machine and Foundry Co.

108. Electron micrograph of corn oil droplets. Original magnification 7700x.
J. PANGBORN/ University of California, Davis

109. Radiograph of poorly-drained swamp deposit.
E. L. KRINITZSKY/ U. S. Army Waterways Experiment Station, Vicksburg, Miss.

110. Radiograph of lake deposit disturbed by turbulence and containing root penetration.
E. L. KRINITZSKY/ U. S. Army Waterways Experiment Station, Vicksburg, Miss.

111. Radiograph of lake deposit showing lacustrine clay partly collapsed from animal burrows.
E. L. KRINITZSKY/ U. S. Army Waterways Experiment Station, Vicksburg, Miss.

North Section

112. Montage of 14 composite photographs from 700 miles above the Earth of the U.S.A. showing it relatively cloud free. Images recorded on tape and transmitted to Earth, summer 1966.
NIMBUS II/ NASA, Goddard Space Flight Center

113. Photograph of Earth made from scans with a 66 degree and a 4.4 degree lens transmitted back to Earth from 22,300 miles.
APPLICATIONS TECHNOLOGY SATELLITE I/ NASA

114. Mosaic photograph made from 6.4 degree scans of Moon's surface transmitted to Earth.
SURVEYOR I/ NASA, Goddard Space Flight Center

115. Photograph of Earthrise from the Moon transmitted to Earth, August 23, 1966.
LUNAR ORBITER I/ NASA

116. Composite photograph of 3 37 degree scans from about 700 miles of Hurricane Inez over Florida with the Eastern seaboard and Great Lakes region relatively clear, October 1, 1966. Image recorded on 1200' tape and transmitted to Earth.
NIMBUS II/NASA, Goddard Space Flight Center

117. Montage of composite infrared photographs from about 700 miles above the Earth at night, July 18, 1966.
NIMBUS II/ NASA, Goddard Space Flight Center

118. Photograph of Moon's surface from 28.4 miles at 4500 mph showing floor of crater Copernicus (60 miles diameter, 2 miles deep, mountains in middle ground 1000' high). Original footage taken Nov. 23, 1966, which was then developed and "read-out" with scanning electron beam and transmitted by November 28, to Goldstone, Cal.
LUNAR ORBITER II/ NASA, Langley Research Center, Hampton, Va.

119. High speed photograph taken with heavy neutral density filter of molten steel bath in an oxygen injected open hearth furnace; flames are approximately 4000 degrees F.
CLARENCE SNYDER/ Bethlehem Steel Corporation

120. High speed photograph of flame approximately 3100 degrees F, in open hearth furnace showing the gas atomization of oil fuel.
LEONARD ROSS/ Bethlehem Steel Corporation

121. Mosaic of 3 photographs from 450 miles above the Earth of Western Europe, transmitted to Lannion, France, September, 1964.
NIMBUS I/ NASA, Goddard Space Flight Center

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Glossary

Electron micrograph: photograph made in an electron microscope, a device based on the use of electrons and electro-magnetic lenses; the image is formed by the transmission and scattering of the electrons, whose short wavelengths allows for greater resolution than in a light microscope.

Electron micrograph scan: picture made in a scanning electron microscope, which, through the use of a narrow beam of electrons scanning the surface of a subject, allows for increased depth of field; the image is formed point by point on a television screen and can then be photographed conventionally.

Evaporagraph: visual record of temperature differences made by infrared radiation which appears as condensation of oil on a special membrane; this image can then be photographed conventionally.

Infrared photograph: image formed by exposure to infrared rays which are outside of the visible spectrum; special film is used as well as filters to eliminate other rays.

False color infrared photograph: photograph made with film sensitive to color and infrared radiation designed to record color differentiation rather than color fidelity.

Interferogram: photograph of air density changes made visible by the interference between the two components of a split light beam; used to make quantitative measurements.

Panoramic photograph: comprehensive view of an area; can be made with a wide angle lens or by joining separate photographs; in this exhibition the term refers to photographs wiped on by lens and/or film movement, from either a fixed or moving vantage point.

Radiograph: picture made by exposure to rays outside the visible spectrum--usually X-rays, whose extreme penetrating power make them useful in recording density.

Schlieren photograph: photograph made by the shadowgraph method in conjunction with an optical system which is more sensitive to air flow changes; image records the differences in the refractive index of air; the schlieren method is used generally to photograph a stationary object in a moving air field.

Serial photograph: photographic record of movement made by the accumulation of successive exposures.

Shadowgraph: direct photographic record of the shadow pattern cast by an object when illuminated by a short duration spark from a point source; generally used to record air density differences produced by a projected missile.

Stroboscopic photograph: photograph whose several exposures are made by the illumination of high speed electronic flashes; used to analyze high speed motion.

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The black-and-white prints in the exhibition were produced by Modernage Photographic Services. The majority of the color prints were made by K & L Color Service, Inc.

The exhibition was directed by John Szarkowski, assisted by Josephine Bradley. The installation was designed by Irving Harper of Harper & George.

Once Invisible was prepared in participation with the Santa Barbara Museum of Art and the University Art Museum, the University of California, Berkeley, and will be shown at those institutions.